

# CUA Physics Student Research Plan **“Ensemble simulations of coronal mass ejections and generation of probabilistic space weather predictions.”**

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## **Summary**

Analysis and modeling of coronal mass ejection (CME) propagation through the interplanetary medium are major topics in current space weather research. As CME simulations enable long lead-time predictions, this line of research has significant implications for operational space weather forecasting capacity. NASA GSFC Space Weather Center is the first entity that started using CME simulations in an operational environment.

So far CME simulations have been based on single model runs that do not provide direct means to dynamically gauge the uncertainty in the model output. Our goal is to move toward systematic characterization of the uncertainty in terms of ensemble approach. In the ensemble approach we use statistical tools to build probability distributions of initial CME conditions. The distributions are then used to launch an ensemble of CME simulations. The ensemble of simulations will eventually provide also an ensemble of predicted CME impacts thus enabling quantification of the uncertainty in the modeling results.

In this research we will study the generation of distributions of initial CME conditions and their usage in launching a very large number of CME simulations. Also various processes used to quantify the uncertainty of the predictions through the ensemble output are studied. This research will benefit directly the CME simulation capacity and the operational space weather forecasting activity at NASA GSFC.

## **Tasks**

- 1.) Learn to identify CMEs in coronagraph imagery. Learn to use tools at NASA GSFC Space Weather Center to analyze the three-dimensional properties of CMEs.
- 2.) Help generating Bootstrap-based ensemble version of the primary CME analysis tool.
- 3.) Identify CME events of space weather interest. These events will be used to study the ensemble approach.
- 4.) Learn to use initial CME conditions to launch simulations in NASA GSFC Space Weather Center and CCMC's supercomputers.
- 5.) Learn to analyze the output from three-dimensional interplanetary plasma simulations.
- 6.) Generate example ensemble space weather predictions using skills acquired through 1-4 above.

**Location and time of the research**

The work will take place during Spring 2012 semester primarily at NASA GSFC Space Weather Center. Office space and desktop/laptop computer will be provided for the research.

**Deliverables**

The primary deliverable of the work is presentation in the CUA Physics undergraduate seminar series. Parts of the work may be published in collaboration with the student.